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Envisioning Next-Generation Model-Based Agile Engineering

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ABSTRACT

The complexity of modern platform systems (e.g., commercial aircraft, spacecraft, and military vehicles) exponentially increases as we add new and advanced capabilities needed to sustain market and military leadership. Modern aircraft are aerodynamically unstable and controlled by hundreds of connected microcontrollers. Spacecraft dock at the International Space Station using artificial intelligence controllers, where humans are the 'backup system.' Military systems use cyber-assured autonomy and cyber-assured fire control on the battlefield. In each of these cases, new and significant engineering challenges arise.

- Complexity Management - System design under the 'constraint of complexity' frequently leads to product cost overruns and delivery delays.
- Dynamic over Statics - Current Model-Based Engineering (MBE) tools and techniques perform well for representing low-complexity systems with low interaction among design elements. However, they do not scale well for representing complex systems having high interaction among design elements.
- Artifact Integrity - Most MBE methodologies do not appropriately integrate artifacts engineering disciplines (e.g., systems engineering, hardware engineering, software engineering, and test engineering) into an authoritative source of truth. Discrepancies in design artifacts may lead to undetected design flaws that leak into product manufacturing and end-user operations.

Our analysis of MBE successes and failures from 2000 to 2020 suggests that we are at an inflection point where future design challenges may exceed the design capabilities provided by today's MBE techniques.

This paper describes operational challenges and associated requirements leading to the development of BAE Systems' Model-Based Agile Engineering (MBAE) methodology. We present five innovations that provide the underpinnings for our MBAE implementation framework. We conclude with a brief description of a recent success story at BAE Systems and recommendations for the next steps in MBAE capability development.

1. INTRODUCTION

The complexity of modern platform systems (e.g., commercial aircraft, spacecraft, and military vehicles) exponentially increases as we continue to add new and advanced capabilities needed to sustain a leadership position in our business markets. Modern military and commercial aircraft are complex, aerodynamically unstable, and controlled by hundreds of interrelated microcontrollers [1]. Spacecraft dock at the International Space Station using artificial intelligence controllers, where "humans are the backup system" [2]. Military systems use cyber-assured autonomy for robotic weapon systems on the battlefield [3]. Each product's increasing complexity is rapidly pushing current model-based engineering practices beyond their practical limits.

Today, many commercial and defense organizations struggle to reliably and affordably deliver complex products to market using existing model-based engineering (MBE) techniques. As shown in Figure 1, our research suggests that MBE capabilities have evolved incrementally over the past 20 years, with each generation building on successes and failures of the prior generations. This incremental progression of MBE capability is insufficient to address current and future product development challenges in many cases. We call the increasing gap between MBE capability and product development needs the 'MBE Capability Gap.'

This paper describes market drivers, solution requirements, and five innovations shaping BAE System's emerging Model-Based Agile Engineering (MBAE) methodology. MBAE is a collection of value-driven, multi-disciplinary engineering techniques that augment traditional and agile project management methodologies with high-performance, value-driven engineering activities. MBAE techniques guide systems, software, hardware, and test engineering activities across the entire product development lifecycle.

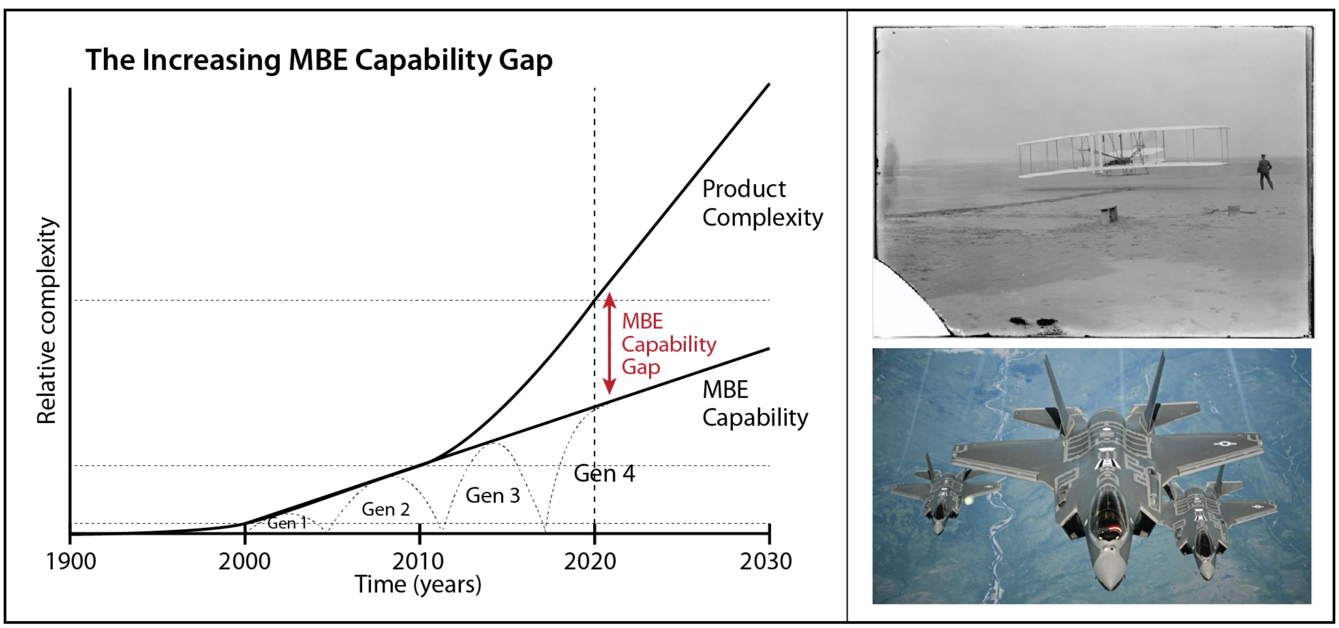

Figure 1 – Model-Based Engineering (MBE) Inflection Point. *Driven by increasing market demands for product features and the rapid advancement of new technologies, MBE is at an inflection point. Current MBE tools and techniques are based on the last decade's market needs and are insufficient for the next decade of product advancements.*

2. HISTORY OF MBE DEVELOPMENT

In 1993, A. Wayne Wymore [4] defined systems engineering as "The intellectual, academic, and professional discipline the principle concern of which is the responsibility to ensure that all requirements for a bioware/hardware/software system are satisfied throughout the life cycle of the system." Wymore is widely considered a co-founder of early MBE techniques and sparked the first generation of MBE tools, processes, and training. As the art and science of MBE evolved, our systems engineering communities experienced successive waves of process, tool, and training innovations. Each wave resulted in lessons learned and best practices that shape the state of MBE today.

Figure 2 shows four distinct generations of MBE development, as experienced in the defense industry and adjacent marketplaces. In each case, acquisition communities inside the Department of Defense (DoD) and National Intelligence Community (IC) made significant investments in MBE capabilities to guide the design, development, and delivery of complex system-of-systems products. Unfortunately, in the first three generations of MBE investment, the fielded MBE capabilities were insufficient to address product development challenges leading to schedule delays, cost overruns, and project cancellations.

To address key MBE challenges, the National Institute of Standards (NIST), the Object Management Group (OMG), the International Council on Systems Engineering (INCOSE), and Systems Engineering Research Center (CERC) regularly conduct root-cause analysis of MBE challenges and develop new strategies for future capability development [5,6,7,8,9]. These strategies provide valuable insights for guiding the development of the next increment of commercial tooling, industry-derived processes, and university-provided training.

BAE Systems actively leverages strategy and guidance from standards bodies, DoD, IC, and other thought-leading organizations to develop our next-generation MBAE capabilities. Our MBAE methodology purposefully accelerates model-based engineering techniques and enables solutions for complex design problems using value-driven techniques.

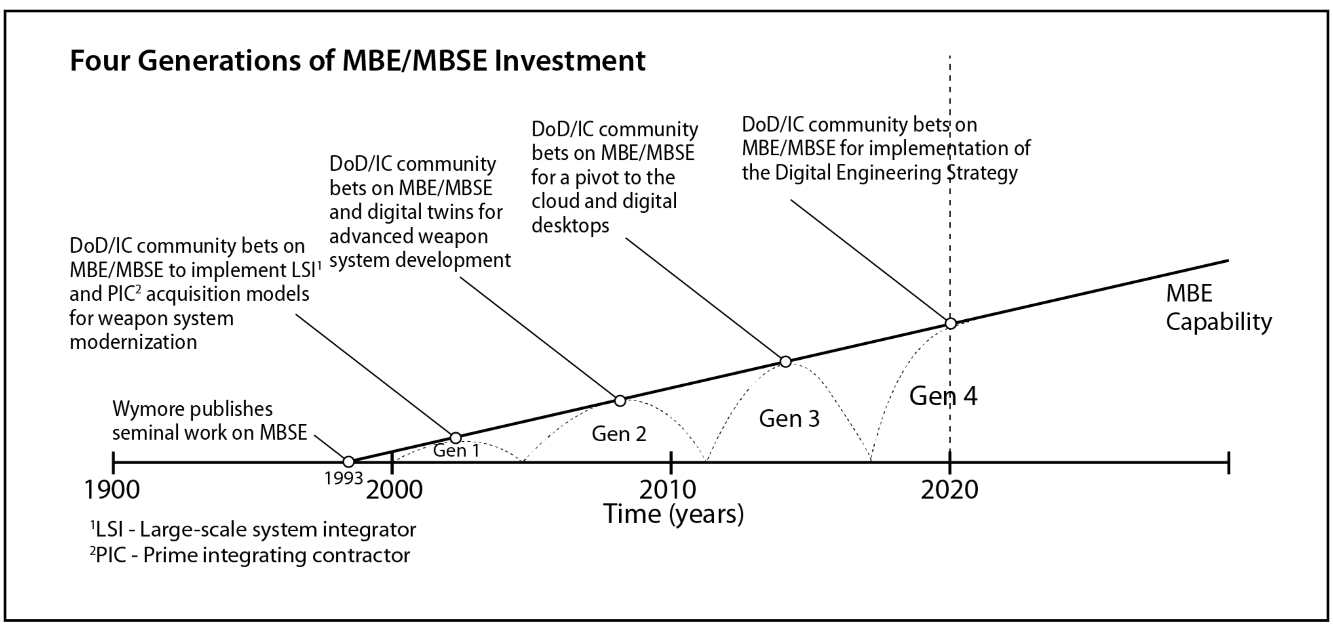

Figure 2 – History of MBE Investment. *Within the DoD and Intelligence communities, MBE progressed through four distinct generations. In many cases, each generation collapsed as MBE fell short on delivering the anticipated value.*

3. FIVE MARKET DRIVERS FOR NEXT-GENERATION MBAE

Many current-day market drivers contribute to increasing the MBE Capability Gap. Table 1 lists five key drivers that contribute to the development of our MBAE methodology. Each driver derives from our experience in the defense marketplace; however, we anticipate that each driver applies equally to most commercial marketplaces.

Under the mantra of 'better, faster, cheaper,' many organizations struggle with decreasing procurement timelines (row 1), decreasing project budgets (row 2), and increasing product complexity (row 3). In many cases, products are over-engineered throughout the development process resulting in inefficiencies that increase development, manufacturing, and delivery risks. In assessing these drivers and their impacts, we recognize that most MBE methods are designed based on decades-old product realization strategies, processes, and technologies. Looking forward, we anticipate that future MBE methods will adopt agile principles [10] to reduce product delivery timelines, emphasize value-driven design, and enable product innovation under the constraint of complexity.

Many businesses are discovering that year-over-year project risks increase as modern requirements lead to more complex product designs. In many cases, product designs leveraging large numbers of embedded microcontrollers and software find that immature dynamic design techniques must augment mature static design techniques (row 4). We anticipate that next-generation MBE methods will emphasize analytics over models, including the analysis of off-nominal product behavior to assure product safety and security.

Finally, while MBE has made great strides toward achieving an authoritative source of truth (ASoT) using federated model repositories, we find that most ASoTs do not incorporate all engineering disciplines equally (row 5). We anticipate that future MBE methods will proactively manage artifacts equally from all engineering disciplines resulting in better aligned and more consistent sources of truth.

Table 1 – Sources of the MBE Capability Gap. *The MBE Capability Gap is a consequence of product acquisition trends, product complexity, and the current state of MBE practice. These market drivers will reshape tools and techniques over the next decade of MBE capability development.*

	MBE Capability Gap Sources		MBE Capability Gap Impacts
Speed to Market	***Acquisition timelines are decreasing*** – The pressure associated with getting new products to market is increasing as the global economy becomes more interconnected, and international competition becomes more intense.	→	Current MBE techniques are based on product development timelines that are over a decade old and do not adequately address the pace of today's hyper-competitive marketplace. New MBE techniques are needed to streamline product development and reduce the 'time-to-market.'
Cost to Acquire	***Acquisition budgets are decreasing*** – Commercial and military contracts are becoming more budget-sensitive as procurement offices shift from 'best value' to 'lowest cost technically acceptable' acquisition strategies.	→	Current MBE techniques are mostly designed from the perspective of Waterfall processes and the 'Vee Model" which focus on 'design completeness'. Future MBE techniques will align with Agile development methods and provide a focus on 'value-driven design'.
Innovation over Complexity	***The complexity of products is increasing*** – To remain competitive, many companies quickly add new features to existing product lines. These features frequently require additional computing nodes (e.g., micro-controllers) and software that create complex interrelationships.	→	The rapid advancement and ubiquitous access to technology is driving new innovation and increased complexity in system designs. Future MBE techniques must provide tools and techniques allowing innovation under the constraint of complexity.
Full Life-cyce Risk Reduction	***Product life-cycle risks are increasing*** – The increasing complexity of products creates a new program and technical risks. Many of these risks are due to dynamic subsystems using adaptive coding, artificial intelligence, adaptive control, and cyber resilience algorithms.	→	As products become more feature rich, the risks associated with delivering effective, safe, and secure products increases. Future MBE techniques much shift from a focus on 'static structural design' to a focus on 'dynamic, adaptive, and resilient design' to address future product development risks.
Cross-Discipline Integration	***Engineering artifacts lack integration*** – While artifacts from individual engineering disciplines (e.g., systems, hardware, software, test, manufacturing) are well integrated, artifacts are not well integrated across disciplines resulting in increasing product defects.	→	As we shift from Waterfall to Agile processes, cross-discipline artifact integration is necessary. Future MBE techniques must focus on maturing mission, data, software, hardware, human factors, and performance designs in unison and in a single artifact repository (artifactory).

4. FIVE REQUIREMENTS FOR NEXT-GENERATION MBAE

By understanding MBE history and current market drivers', we can identify requirements that lead to a next-generation MBE methodology. Table 2 highlights five requirements that shape our current MBAE method. First, future MBE methodologies shall adopt agile principles and practices (row 1). While this sounds like a small task, our experience suggests that introducing agile principles to an engineering organization can be a significant cultural challenge. Agile engineering processes fundamentally shift project thinking from a 'just-in-case' tempo to a 'just-in-time' tempo that focuses on continuous risk reduction across the entire product lifecycle.

Second, future MBE methods shall focus on 'modeling for value' in contrast to 'modeling for completeness' (row 2). Value-driven modeling is also a significant cultural change as many project engineers strive for 100% complete models that extend well beyond their intended purpose. MBAE focuses on performing 'just-enough modeling' to address identified project challenges and risks resulting in planned and purposeful modeling efforts.

Third, future MBE methods shall emphasize 'analysis over models' whereby the analytic engine (e.g., mathematical calculations, simulations, and safety and cybersecurity assessment) determines the model's structure and content (row 3). Today, tools (e.g., MagicDraw, Sparx Enterprise Architect) and notations (e.g., UML, SysML, BPML) shape and guide most MBE methods. Unfortunately, this 'tools-first' focus frequently results in models that cannot support the model analysis needed to address product complexity and product development risks. MBAE reverses this process by focusing on providing an 'analytics-first' approach whereby the model's structure and attributes derive from the analytic engines and their need for data.

Table 2 – Requirements for Model-Based Agile Engineering (MBAE). *MBAE restructures current MBE techniques by reversing the value chain: User Value → Model Analytics → Model Structure → Modeling Tools. Our application of MBAE shows that if we understand the user value proposition, the selection of model structure and tools becomes obvious.*

	Next-Generation MBAE Requirements	MBAE Solution Approach
Holistic Agile Engineering	***Model-Based Agile Engineering (MBAE)*** – Next-generation MBAE shall embrace the tenets of Agile Systems Engineering [1] with a focus on continuous risk reduction and value-creation across the product life-cycle.	MBAE is a collection of discipline specific, high-performance, value-driven engineering practices that augment traditional Waterfall and Agile product management methodologies. The MBAE practices are modular and tailorable to individual project needs.
Definition of Doneness	***Model for Value - not for Completeness*** – Next-generation MBAE shall focus on developing and analyzing models to address specific analytic questions (AQs). The 'definition of done' for each model shall be based on value creation and not artifact completeness.	MBAE is a value-driven engineering structured around analytic questions (AQs) and development of engineering artifacts than answer AQs. Analytic questions derive from program risks, hard operational problems (HOPs), hard technical problems (HTPs), and most important requirements (MIRs).
Analysis Defines Model Content	***Analytics over Models*** – Next-generation MBAE shall emphasize the analysis of models as a vital component of the continuous risk reduction and value-creation process.	MBAE uses analysis techniques to define a model's structure. Models develop using syntax, semantics, and meta-data as needed to support analytic computations and decision making.
Source of Truth	***Multi-Functional Artifactory*** – Next-generation MBAE shall provide an artifact repository (artifactory) that encompasses all engineering disciplines (mission, data, software, hardware, human factors, and performance engineering) and artifacts needed through the entire the product development life-cycle.	MBAE uses a hybrid model repository, structured about a Zachman-like classification schema, to organize multi-functional engineering artifacts across the entire project life-cycle. This repository is an inclusive extension of the MBSE model repository concepts.
Redefining the SE Role	***Systems Engineering as Agile Risk Reduction*** – Next-generation MBAE shall redefine systems engineering's role to become the primary agent of project risk reduction across the full product life-cycle (requirements to factory).	MBAE redefines systems engineering as a risk reduction function performed across the full project life-cycle. As risk reduction agents, systems engineers are members of each functional integrated product team (IPT) on a development program.

Fourth, future MBE methods shall provide a trustworthy, multi-disciplinary artifact repository allowing both management and technical artifacts to be rigorously linked, thereby increasing total project integrity (row 4). Many product lifecycle management (PLM) capabilities are emerging that offer foundational capabilities; however, organizational adoption is still slow due to cost constraints and cultural challenges.

Finally, systems engineers' roles and responsibilities shall shift from early requirements analysis, architecting, and design activities to full-lifecycle risk mitigation activities (row 5). Traditional waterfall thinking currently traps many product development organizations, hindering needed process innovation. Re-envisioning SE role breaks with this tradition, redefining roles that, in our experience, significantly enhances productivity and reduces the risk for most production programs.

5. FIVE MBAE INNOVATIONS

The five requirements for next-generation MBAE methods, described in section 4, encourage fundamental changes in how we perform future model-based engineering activities. These requirements motivate us to break away from the historical focus on 'tools and models' and shift toward a more modern focus on full-lifecycle 'value-creation and agility.'

5.1 Focus on Model-Based Agile Engineering Techniques

BAE System's implementation of Model-Based Agile Engineering (MBAE) provides a modular toolkit consisting of high-performance engineering techniques tailored to satisfy individual project needs. Figure 3 shows the relationship between standard project management techniques and MBAE techniques. Figure 3 shows the relationship between standard project management techniques and MBAE techniques. In this construct, project management techniques describe how the project executes, whereas MBAE techniques describe how to perform engineering tasks. This distinction between project management and engineering implementation is a common point of confusion among projects using agile management methods like eXtreme Programming, Scrum, and Scaled Agile.

Using MBAE, we perform multi-disciplinary engineering work using integrated product teams

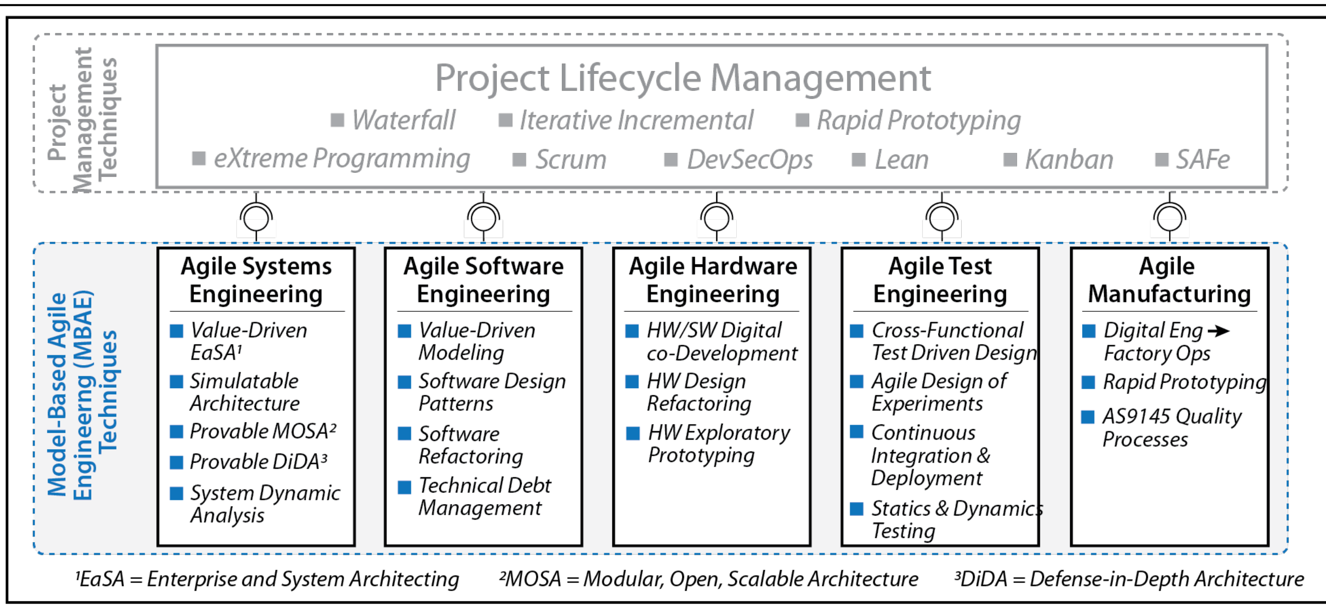

Figure 3 – Model-Based Agile Engineering is a toolkit of Best Practices. *MBAE is a toolkit of best practices for value-driven, high performance, multi-disciplinary engineering. MBAE augments a wide range of project management techniques (waterfall-to-agile), and is tailorable to suit specific project needs and deliverables.*

(IPTs), including systems, software, hardware, test, and manufacturing. We define specific modeling activities and techniques within each engineering discipline that guide engineering tasks using value-driven, agile principles. Recent pilots of our MBAE methodology on defense and intelligence community projects suggest that the collective set of MBAE techniques allows engineering teams to reduce schedule risks, reduce development costs, and innovate under the constraint of complexity.

5.2 Focus on Modeling for Value – not for Completeness

As many products become more complex, the feasibility of building holistic and complete digital twins decreases. We acknowledge that digital twins do create value in circumstances where:

1. The physical system is safety-critical (e.g., a passenger airline),
2. The physical system is unique, expensive, or fragile (e.g., a space telescope)
3. The physical system is remote and inaccessible (e.g., an interplanetary rover).

However, in cases where these circumstances are not present, digital twins may be unnecessary. They may not create enough benefit (e.g., risk reduction, complexity management, technical insight) to warrant high resource costs. In these cases, value-driven digital threads are a viable alternative.

Figure 4 shows, MBAE shifts from heavy-weight digital twins to light-weight digital threads that incrementally reveal the product architecture. The process of applying digital threads is analogous to a painting a picture where the important elements of the scene are gradually revealed by the artist. The resulting product models have high-fidelity in areas of high-complexity and low-fidelity in areas of low complexity.

MBAE uses analytic questions (AQs) to identify and prioritize digital threads for development. AQs are problem statements derived from project risks, hard operational problems (HOPs), hard technical problems (HTPs), and most important requirements (MIRs). Each AQ is used to reveal a digital thread describing, step-by-step, the desired product solution (structure) and

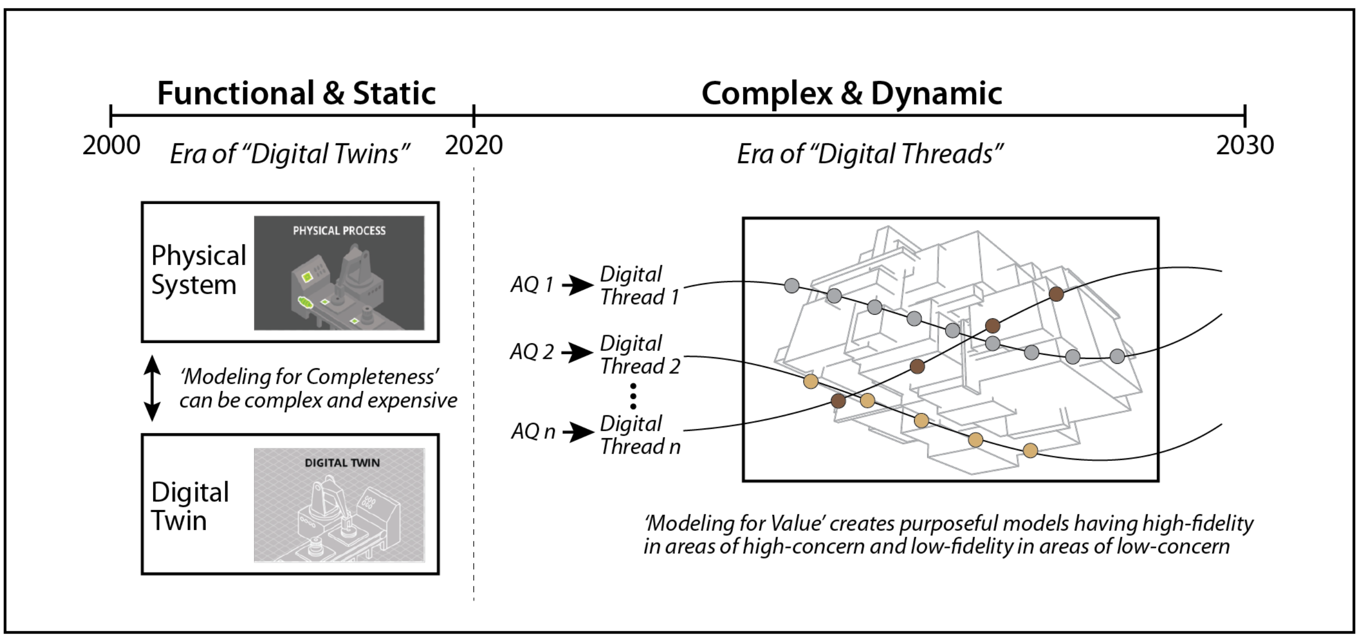

Figure 4 – Model for Value – not for Completeness. *While digital twins are sometimes needed, most complex product engineering is better served by modeling high-value digital threads. Digital threads, defined by analytic questions, result in system design having high-fidelity in high-risk areas, and lower-fidelity modeling is lower-risk areas.*

behavior (dynamics). Each digital thread is further analyzed using model-based analysis and design techniques to elaborate key product architecture and design areas. As the set of AQs is resolved, the ensemble of digital threads creates a product architecture having high fidelity in high-risk areas and low fidelity in low-risk areas.

5.3 Focus on Analytics over Models

For the past two decades, MBE and MBSE primarily focused on tools, modeling notations, and processes to build models describing systems architecture and design. This infrastructure-focused approach to MBE resulted in well-populated model repositories; however, these repositories frequently did not create value for the project team or the product development. A fundamental problem with this modeling approach is that systems engineers often build models outside of a well-defined need identified by an end-user.

Figure 5 shows our next-generation focus shift from 'building models for completeness' to 'analyzing models for decision making.' In this approach, the modeling process begins with user needs analysis, identifies required value-driven outputs, and defines analytic engines needed to perform analysis, design, and risk reduction activities. Notably, with this approach, the models become data sources and the modeling tools become content authoring appliances. Our experience shows that this paradigm shift maximizes value creation for end-users and appropriately focuses project resources on solving relevant, complex problems throughout the product development lifecycle.

Finally, the increased emphasis on 'value creation' over 'rote modeling' is a primary tenet of most agile methodologies and is well articulated in Sandia National Labs' Model-Based Engineering (MBE) Manifesto [10]. It ends the two decades of paralysis and inefficiencies caused by the over-emphasis on modeling tools, notations, and processes and shifts our focus toward creating immediate and continuous value for end-users and the product value stream.

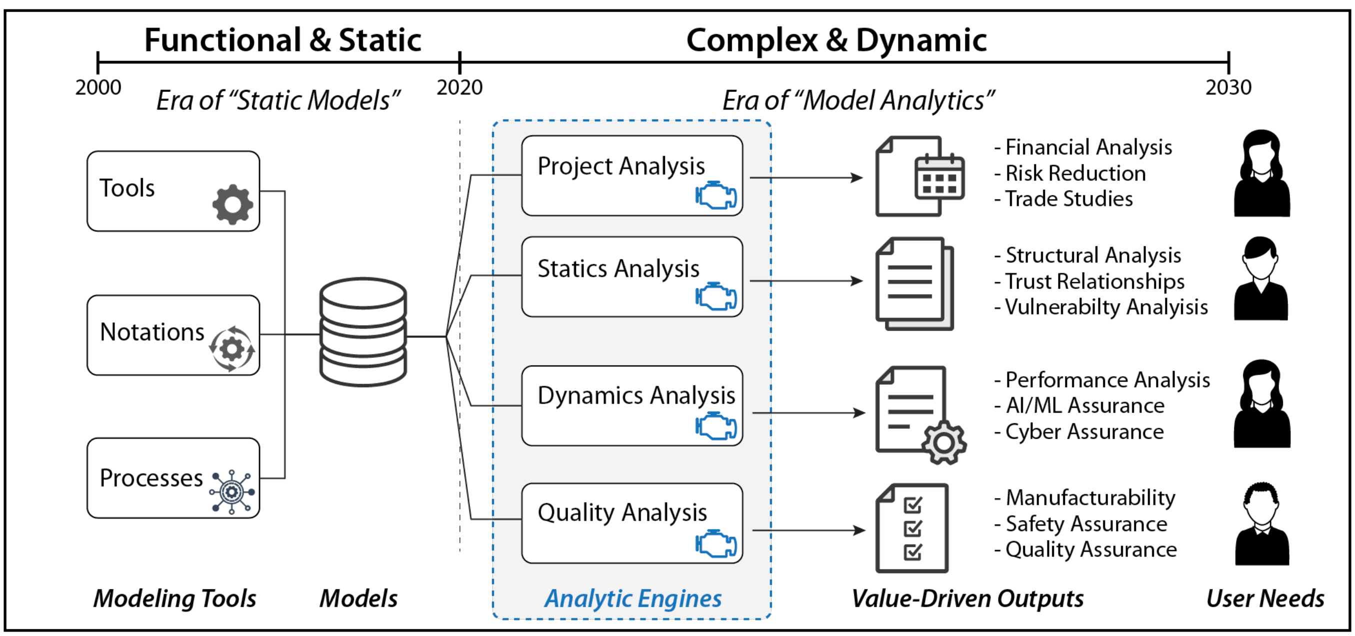

Figure 5 – Value through 'Analytics over Models'. *MBAE focuses on continuous value creation by concentrating on user needs, analytic outputs, and the analytic engines needed to solve complex and dynamic problems. In most cases, defining the analytic value chain defines the required model structure (syntax, semantics, and information content) and the appropriate modeling tools.*

5.4 Focus on 'Multi-Discipline Authoritative Source of Truth'

Many MBE and MBSE methodologies describe the need for a common artifact repository providing an authoritative source of truth (ASoT) to guide effective and efficient product development. The ASoT links digital and non-digital artifacts into a single model repository representing a product's architecture and design. However, in practice, many product development teams maintain separate repositories spread across various engineering disciplines, including systems engineering, hardware engineering, software engineering, test engineering, and manufacturing. Many factors contribute to this lack of integration, including

1. Model repositories are often dependent on specific toolsets,
2. Project teams do not establish model repositories that include all of the necessary engineering disciplines,
3. The information technology environment is not well connected, and project teams scatter artifacts across the business enterprise.

The design of a multi-disciplinary project ASoT, called an artifactory, addresses many of these limiting factors.

Figure 6 shows our Multi-Discipline Artifactory structure to integrate six technical disciplines (i.e., Mission, Data, Function/Software, Hardware, People/UI, Time/Performance) across the entire project lifecycle from concept to operational product. Populating the artifactory begins with each engineering discipline selecting a core set of artifacts per their development processes and procedures. These artifacts link vertically within each discipline and horizontally across each discipline, thereby providing design consistency and integrity. The Artifactory is used throughout the entire product lifecycle to store project artifacts, provide a foundation for the product ASoT, and improve cross-discipline communication throughout the product development lifecycle.

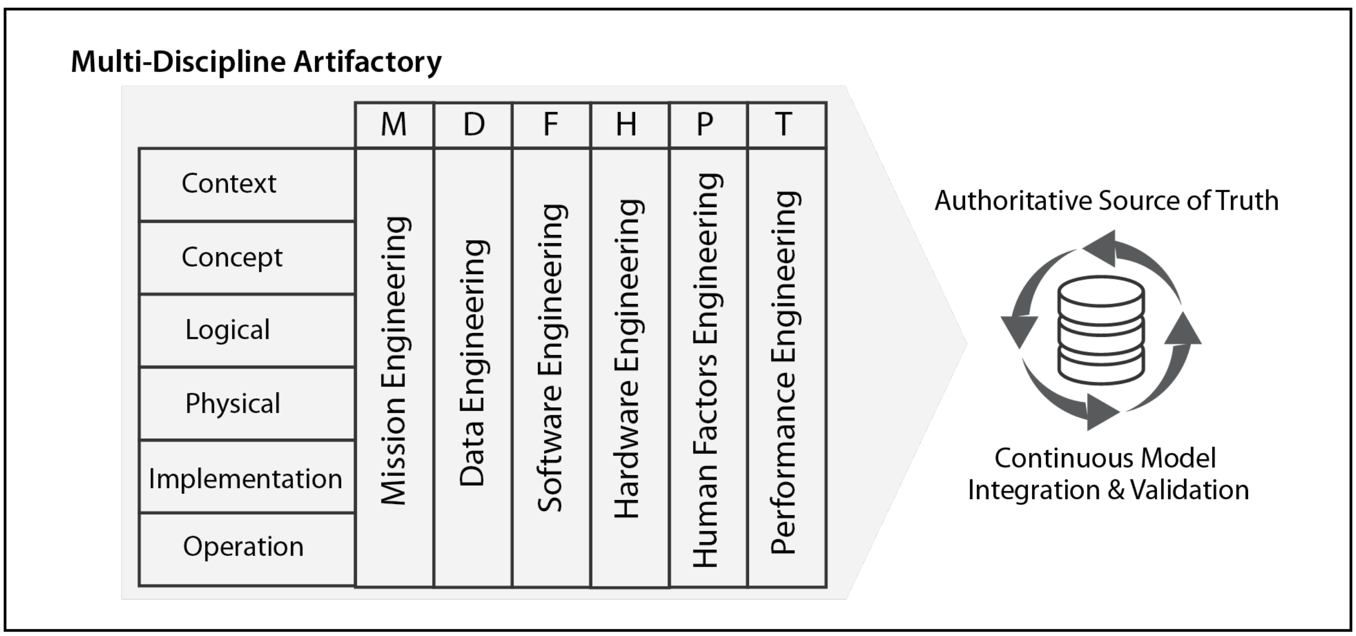

Figure 6 – Multi-Discipline Authoritative Source of Truth (ASoT). *Our MBAE Artifactory creates an ASoT connecting together mission, data, software, hardware, human factors, and performance engineering disciplines. Engineering artifacts in the MBAE Artifactory include Mission models, UML/SysML/BPML models, CAD/CAM models, timing and performance models, lifecycle cost models, and other non-model artifacts.*

5.5 Focus on Systems Engineering as a Risk Reduction Activity

In many organizations, project managers view systems engineering (SE) as an early lifecycle activity focused on achieving early project milestones, including system requirements review (SRR), preliminary design review (PDR), and critical design review (CDR). After these early project milestones are complete, the program disbands the SE team and replaces it with product development teams. This practice of disbanding the SE team often allows the as-designed and as-built product architectures to diverge and consequently increases downstream development and manufacturing risks.

Figure 7 shows how MBAE re-envisions the role of the systems engineer as a full lifecycle risk reduction agent. In this new role, systems engineers enable design, development, and manufacturing teams by anticipating and eliminating potential roadblocks. Risk reduction activities are defined and prioritized using agile project management techniques and AQs to focus systems engineering activities. Each AQ has a specific structure, including (at a minimum) a title, a description, a list of deliverables, a completion criterion (e.g., a definition of doneness), and a time/budget estimate. A project backlog manages the complete collection of AQs and links to the development teams' agile stories. This backlog allows SE work packages to be dynamically prioritized based on strategic (long-term) and tactical (short-term) project needs. It assures that the SE team is constantly creating value for the development teams.

The use of agile management techniques and a focus on value creation through risk reduction provides a new and unique role for systems engineering on development programs. The SE becomes a risk reduction agent on these programs that focuses on removing project roadblocks and enabling development teams to perform with increased velocity and efficiency. This role is performed across the full project lifecycle and embeds into the product implementation teams. Finally, our experience at BAE Systems suggests that this redefinition of the systems engineering role is critical to guiding cultural change and encouraging the adoption of MBAE principles.

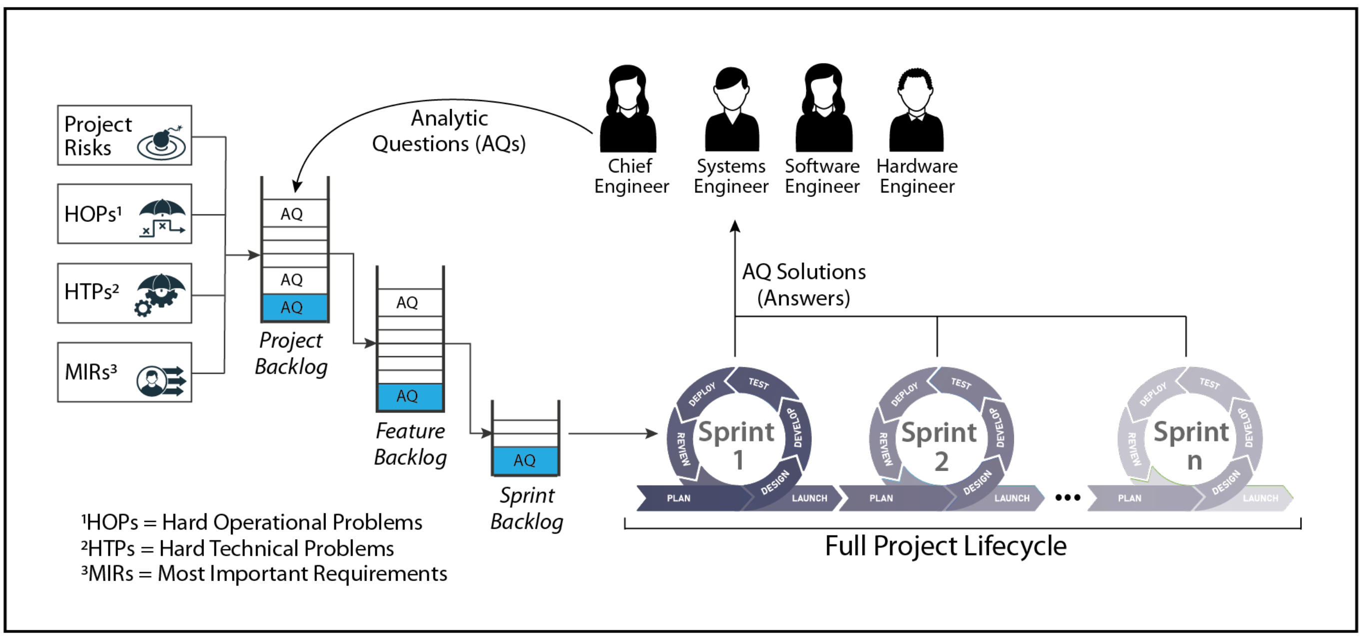

Figure 7 – Systems Engineers as Full Lifecycle Risk Reduction Agents. *MBAE redefines systems engineering as a horizontal integrator across disciplines whose activities are guided by analytic questions (AQs). AQs focus risk reduction activities and are defined by identifying and analyzing project risks, hard operational problems, hard technical problems, and most important requirements.*

6. MODEL-BASED AGILE ENGINEERING SUCCESSES

BAE Systems has over ten years of experience with MBAE techniques applied to DoD and IC programs ranging from large-scale aircraft programs to small form factor radio frequency (RF) module development. Developed in 2010, MBAE continues to advance the state of practice for systems engineering throughout our business.

We recently applied MBAE to a 30-week, rapid development project focused on designing and de-risking core elements of our digital transformation strategy, including infrastructure for Advanced Product Quality Planning (APQP) and Failure Reporting, Analysis, and Corrective Action System (FRACAS) functions. We applied Agile Scrum to manage the project rhythm and MBAE to manage the systems engineering activities. Each agile product increment was six weeks in duration (3 agile sprints), with formal product releases at the end of each increment. Each agile sprint was two weeks in duration, with interim product demonstrations at the end of each sprint.

At the beginning of the project, we established a multi-disciplinary artifactory consisting of placeholders for 24 key artifacts. These artifacts provided a robust set of design views across the project scope (i.e., from mission to logical implementation) and across technical disciplines (i.e., Mission, Data, Function/Software, Hardware, People/UI, Time/Performance). Further, each artifact was developed incrementally based on its linkage to analytic questions (AQs) to describe project risks and prioritize the systems analysis and design activities.

MBAE tasks were described as AQs, the MBAE equivalent of agile software stories, and stored in a project backlog. Each AQ described an identified project risk, hard technical problem, or hard operational problem and was prioritized for analysis during sprint planning sessions at the beginning of each sprint. For each AQ, we selected a minimum subset of artifacts needed to support analysis and design activities focused on identifying solutions for the AQ. Through addressing nearly 100 AQs, the resulting artifact set had high fidelity in high-risk areas and low fidelity in low risk areas. Additionally, the artifact set provided risk reduction blueprints for implementation teams in the development and deployment phases of our APQP/FRACAS project. The resulting risk reduction blueprints saved over five hundred thousand dollars in the capability acquisition costs. Furthermore, they reduced the technical implementation risk to an acceptable level allowing implementation teams to quickly and affordably deliver production-ready capabilities.

7. CONCLUSIONS

Addressing the emerging MBE Capability Gap, caused by increasing product complexity and insufficient model-based engineering capabilities, is rapidly becoming necessary in many industries. The defense, intelligence, and aerospace industries are no exception. Rapidly changing mission needs, evolving market opportunities, and technology innovations required that we adapt to meet the demands of more complex systems environments, driving us to develop and deploy next-generation MBAE processes. When adopted by an engineering organization, the five key innovations described in this paper lead to technical, procedural, and cultural advancements that enable system design under the 'constraint of complexity.' The five key innovations include:

- Focus on Model-Based Agile Engineering Techniques
- Focus on Modeling for Value – not for Completeness
- Focus on Analytics over Models
- Focus on Multi-Disciplinary Authoritative Sources of Truth
- Focus on Systems Engineering as a Risk Reduction Activity

By integrating MBAE techniques into existing project management processes and systems engineering workflows, we accelerate value creation for project engineers and significantly reduce project risks. At BAE Systems, we expect that our pilot projects, combined with ongoing investments across the defense and commercial industries, will continue to modernize model-based engineering tools and techniques as we evolve to meet the increasing complexity of modern warfighting systems.

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